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with statistics showing the frequency of wounds in certain locations and its bearing on the armor problem.

The utilitarian side is shown and the advantages and disadvantages are carefully weighed. Of interest to metallurgists are tables showing the ballistic values of various metals used for armor and one interesting chapter is devoted to the subject of "yielding" armor, such as padded cotton and silk fiber. Indeed the matter is viewed both from a distance and in minute detail.

The experimental types of armor of all countries are shown and reasons given for their success or failure.

Dr. Dean's summary and conclusions are of particular interest. He believes that we have not as yet solved the problem of providing the best alloy for armor and that the end, as far as the improvement of thin plate for ballistic use, is not yet in sight.

The old struggle between bullet-proof armor and armor-piercing bullets is still on, although at the present time the armor seems to have the advantage.

The question of the best form of the American helmet is also considered. At present we are still using the British helmet and American experts agree that this model does not give sufficient protection to the back and sides of the head. Moreover, a national type should be adopted.

The question as to whether armor will be used in the future hinges not a little on the problem of getting transports to the front. The infantry-man carries a maximum necessary load without his armor which would therefore have to be sent up to him.

Considerable prejudice among the men also accounts for the unpopularity of armor—they do not wish to be burdened with it and would rather take the chances on being hit. But as the author puts it, if they can be made to see that it is really worth while, this prejudice may be overcome.

Dr. Dean, from his careful study of ancient armor and his practical knowledge of modern conditions, is qualified to speak with authority on the subject. In designing the modern hel-

met, a comparative study was made of the more ancient ones in the Armor Hall of the Metropolitan Museum of Art. Diagrams showing the development of armor were used and every type of helmet used with success in the past was carefully studied. If it seemed practical, a modern adaptation was designed and beaten out by hand. Due allowance was made in the design for its eventually being pressed out in millions by modern machinery. By this common-sense method Dr. Dean was able, in a comparatively short time, to weed out the impractical forms and to develop a modern type of armor made by machinery for modern warfare.

Who can say, but what it may not yet be used?

DWIGHT FRANKLIN

SPECIAL ARTICLES

DECOMPOSITION OF HYDROGEN PEROXIDE BY ORGANIC COMPOUNDS AND ITS BEARING ON THE CATALASE REACTION

THE last few years have witnessed a revival of unusual interest in the oxidizing enzymes and more particularly in catalase. The catalase reaction derives its interest from the fact that according to recent interpretations it is supposed to be a measure of the metabolic function of living matter. This view, entertained some twenty-odd years ago by Spitzer,¹ has been given much currency in late years by Burge whose numerous contributions to this topic are well known.

Considering the process of intracellular oxidation which is still very obscure it is possible to recognize three factors or enzymes involved in some way or other in the reaction. Of these the oxidases affect the oxidation of easily oxidizable substances directly; the peroxidases accomplish this indirectly by activating part of the oxygen of peroxides; lastly, the catalases by decomposing peroxides liberate inactive or molecular oxygen. It was in this sense that Loew² employed the designation "catalase" for the enzyme which may ultimately turn out to have no relation to the

¹ Spitzer, *Arch. ges. Physiol.*, 67, 615-656, 1897.

² Loew, Report 68, U. S. Department of Agriculture, 1901.

oxidation of organic substances. The occurrence of catalase is so general in plant and animal tissues that its existence certainly must have a significance. Loew conceived the idea that peroxides are formed in the cells in the process of respiration, and that the catalase saves the protoplasm from being injured by these peroxides by decomposing them as fast as they are being formed. Usher and Priestly³ have shown that in plants at any rate hydrogen peroxide is actually one of the substances formed under the action of light and, if not immediately destroyed by catalase, will bleach the chlorophyll and thus interfere with the photosynthetic reaction. In the last few years the work of Appleman, Zaleski and Rosenberg, Loevenhart and Kastle, Alvarez and Starkweather, McArthur and notably of Burge have drawn attention to the probable function of catalase as an index of metabolic activity. Our interest in catalase originated with this fundamental problem of the relation of catalase to tissue metabolism. It may be mentioned that since our research has been in progress a number of papers appeared by Becht,⁴ Stehle,⁵ Reimann and Becher⁶ which not merely challenge the interpretation which Burge and others place on catalases, but also their experimental findings.

The observations of which this is a preliminary report, although not bearing directly upon the fundamental problem of the catalase function, throw nevertheless interesting light on the subject. The literature contains many instances of inorganic substances, such as colloidal platinum and several others which possess remarkable catalytic power, and bring about reactions characteristic of enzymes. Thus Sjollemann⁷ found that colloidal manganous oxide gives all the typical reactions for oxidases. Again Wolff⁸ showed that certain

iron salts can play the part of peroxidases, while Bredig's⁹ "inorganic ferment"—a colloidal platinum—is capable of decomposing hydrogen peroxide as vigorously as catalase. There is, however, no record of organic substances simulating a biological process. We have discovered a group of aromatic hydrocarbons and their derivatives which give the typical catalase reaction. Such substances may undoubtedly help to throw light on the chemical structure and characteristics of the enzyme itself.

Our numerous experiments which we will report in detail later arose from the accidental observation that an enzyme preparation preserved with toluol had acquired a remarkably increased capacity for decomposing hydrogen peroxide. It was at that time also that a paper appeared by Euler and Blix¹⁰ on yeast catalase in which these authors state that the catalase is activated by several substances, toluol among them. The idea of an activation of the enzyme by toluol seemed entirely improbable from our experience, because we found that even such minute quantities of toluol as 0.05 or 0.1 ccm. can decompose hydrogen peroxide. We undertook therefore to examine a number of related organic compounds in the hope of finding whether this non specific catalase reaction is in any way associated with the chemical structure of the organic catalysts. Starting with benzene we studied a number of its homologues and some of its derivatives. Benzene was found to react most vigorously, 0.2 ccm. liberating about 20 ccm. of oxygen from hydrogen peroxide in a manner so closely resembling the effect of an active enzyme preparation that one could not tell the difference unless informed as to the material used in the test.

The aromatic hydrocarbons of the benzene group form a series according to the number of methyl radicles attached to the ring with a gradually decreasing power to decompose hydrogen peroxide, thus:

Benzene > Toluol > Xylol > Mesitylene

⁹ Bredig, "Anorganische Fermente," 1901.

¹⁰ Euler und Blix, *Ztschr. physiol. Chem.*, 105, 83-114, 1919.

³ Usher and Priestly, *Proc. Roy. Soc. London*, 77B, 369, 1906.

⁴ Becht, *Am. J. Physiol.*, 48, 171-191, 1919.

⁵ Stehle, *J. Biol. Chem.*, 39, 403, 1919.

⁶ Reimann and Becker, *Am. J. Physiol.*, 50, 54, 1919.

⁷ Sjollemann, *Chem. Weekblad*, 6, 287-294, 1909.

⁸ Wolff, *C. r. Ac. Sc.*, 146, 142-144, 781-783, 1908.

